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Nitrate availability is generally considered to be the limiting factor for oceanic new and export production and this concept is central in our observational and modeling efforts. However, recent time-series observations off Bermuda and Hawaii indicate a significant new production in the absence of measurable nitrate. Here we estimate global new production in nitrate-depleted tropical and subtropical waters with temperatures higher than 20 degree (Celsius) from the decrease in the salinity normalized total dissolved inorganic carbon inventory within the surface mixed layer corrected for changes due to net air-sea carbon exchange. This method yields a global new production of 0.8 giga ton carbon per year, which accounts for a significant fraction of the recent total new production estimates in the tropical and subtropical oceans, with the remainder being supported by upward nutrients into the euphotic zone through eddy diffusion and turbulent mixing processes. Our modeled value is the first global-scale estimate of new production in the absence of measurable nitrate. We hypothesize that it is attributable to nitrogen fixing microorganisms, which can utilize the non-limiting nitrogen and thereby bypass nitrate limitation. This reported new production is significantly higher than published global nitrogen fixation estimates based on extrapolation of sparse measurements of nitrogen fixation.

OS32I-12 1640h

The Influence of the Subtropical Oceans on Atmospheric Carbon Dioxide.

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Ocean general circulation and biogeochemistry models exhibit a much enhanced sensitivity of atmospheric carbon dioxide to perturbations of the warm surface water properties when compared to classical box models (Broecker et al., Global Biogeochemical Cycles, 13, 817-820, 1999). We demonstrate that this is attributable to the action of the wind-driven circulation and prescence of the ventilated thermocline in the circulation models.

We use an ocean circulation and abiotic carbon cycle model configured in an idealized sector with a coupled atmospheric reservoir of carbon. We compare solutions where the circulation model is driven purely by buoyancy forcing against those with both buoyancy and wind forcing. The model with wind forcing develops subpolar and subtropical gyres and a ventilated subtropical thermocline. The warm lens of the ventilated thermocline is depleted in carbon relative to the surrounding, cooler waters and inherits its properties from the mid-latitude surface ocean at the point of subduction. It is several hundred metres thick and represents a significant ocean carbon reservoir. The sensitivity of atmospheric carbon dioxide to perturbations of low and mid-latitude surface water properties is significantly enhanced in the model with wind forcing, relative to the model with only buoyancy forcing, facilitated by modulation of the carbon budget of the ventilated thermocline. Many highly idealized box models are analagous to the sector model with only buoyancy forcing, having no representation of the ventilated thermocline or its influence on atmospheric carbon dioxide. On the other hand, the wind-driven gyres are partially resolved in global general circulation models leading to their enhanced their sensitivity to subtropical surface perturbations.

The results of these models may be extrapolated to speculate that a global-scale cooling of the ventilated thermocline by 4 degrees during glaciation could reduce atmospheric carbon dioxide on the order of 15 ppmv by this mechanism. Thus, excluding possible changes in the biological pumps, the subtropical thermocline might exert a significant, but not dominant, influence on changes in atmospheric carbon dioxide.

OS32J HC: 323 C Wednesday 1330h

Biogeoinformatics: Challenges at the Intersection of Biological, Biogeochemical, and Physical Data Over Multiple Scales of Space and Time I

Presiding: **R W Buddemeier,** University of Kansas**; R Luettich,** Department of Marine Sciences

OS32J-01 1330h

Non-electronic Sources of Biogeographical Data

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Most historical data and many data currently being collected that are relevant to marine biogeography are unavailable electronically. Putting them into a form that can be stored and used electronically is time-consuming but essential for many purposes. Historical data provide a time dimension of centuries, producing a baseline obtainable in no other way when environmental change is occurring on a scale of decades. Even point measurements of environmental variables can be informative. Taxonomic identification of very few kinds of organisms is possible by remote sensing. Assembling information from museum catalogs – even electronic ones – cannot produce comprehensive taxon lists except, perhaps, for taxa with few members. The presumed difficulties of capturing non-electronic data are primarily those of entry. The human effort involved in entering these data is not so different from that needed to manipulate electronic data (by converting, editing, parsing, etc.) to make them useful for particular purposes.

URL: http://www.kgs.ukans.edu/Hexacoral/

OS32J-02 1355h

Data Assimilation for Modeling and Predicting Multiscale Coupled Physical-Biological Interactions in the Sea

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Data assimilation is now being extended to interdisciplinary oceanography from physical oceanography which has derived and extended methodologies from meteorology and engineering for over a decade and a half. There is considerable potential for data assimilation to contribute powerfully to understanding, modeling and predicting biological-physical interactions in the sea over the multiple scales in time and space involved. However, the complexity and scope of the problem will require substantial computational resources, adequate data sets, biological model developments and dedicated novel assimilation algorithms.

Interdisciplinary interactive processes, multiple temporal and spatial scales, data and models of varied accuracies and simple to complex methods are discussed. The powerful potential of dedicated compatible data sets is emphasized. Assimilation concepts and research issues are overviewed and illustrated for both deep sea and coastal regions. Progress and prospectus in the areas of parameter estimation, field estimation, models, data, errors and system evaluation are also summarized.

OS32J-03 1410h

The Use of Near Real Time, High Resolution Fish and Environment Data in an Aedvanced Fisheries Management Information System

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Working under the hypothesis that more frequent information would help to improve science and management practice, we have built a prototype operational advanced fisheries management information system (AFMIS). AFMIS, which consists of ocean data, a suite of coupled data assimilation models, and a data and information management system, is designed to be operated in near real time and is able to provide frequent (hourly to weekly), high resolution (1-10km), multi-species fisheries nowcast and forecast information. In this implementation the Harvard Ocean Prediction System (HOPS) ocean circulation model is linked with a highly simplified fish model that simulates fish movement as a combination of swimming toward a preferred temperature–"advection"–and a background random searching–"diffusion." To obtain some of the data needed by AFMIS, we have partnered with a fleet of 20 commercial ground fishing vessels, from which selected fishermen obtain the in situ ocean environment and fisheries (up to 50 species) data. The fleet observations, as well as Fleet Numerical Meteorological and Oceanographic Center model meteorological forcing data and satellite imagery, are being assimilated into an ongoing weekly series of prototype AFMIS nowcasts and forecasts. Since November 2000, coincident bottom temperature and fish catch data have been collected during about 4700 separate trawls. This unique data set provides fish abundance estimates and associated environmental data for up to 50 species, with the target species of primarily yellowtail flounder during winter and codfish and/or haddock during spring/summer. The fish abundance estimates exhibit the typical three orders of magnitude range with a significant number of zero catches. Our efforts to explain these large variances in terms of physical environment and fish behavior will be discussed.

OS32J-04 1425h INVITED

The Partnership for Interdisciplinary Studies of Coastal Oceans: Enabling Flexible Data Management Within a Long-Term, Large-Scale Consortium

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The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) is investigating how physical oceanographic phenomena influence near-shore community structure over large geographic scales. Many of the important questions about the near-shore ocean environment remain unanswered and require data drawn from both oceanographic and biological sciences. Integrating these types of data presents an information management challenge, because each discipline produces inherently different types of data. PISCO generates two broad and disparate types of data: physical oceanographic data that are high volume, homogenous measurements (e.g., current velocity and direction), and biological data are often low volume, heterogeneous

observations (e.g., measures of invertebrate distribution). Information management in such an environment requires coordination at all stages of the data-lifecycle: acquisition and documentation of data; integration, interpretation, and analysis of data; and the long-term preservation of data. At PISCO, we are working with partners in the ecological informatics community to design, develop, and implement internet-based software tools that allow researchers to manage disparate data. These tools include desktop and web-based programs that enable researchers to use structured data descriptions to identify and interpret relevant data sets.

URL: http://www.piscoweb.org

OS32J-05 1515h INVITED

Toward A Global Assessment Of Potential Seagrass Habitat

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The assessment of ecosystem function and viability is critical to understanding fundamental biosphereic function and for predicting the impacts of climate change on these systems. At the local scale, our scientific understanding often leads to relatively complex models that seek to embody the relevant physical forcing functions into mechanistic formulations. The mechanistic detail can generate accurate predictions and is necessary as a research tool for furthering our understanding of ecosystem function. Data required to parameterize these models, however, is often not available, particularly at the temporal and spatial scales needed to extrapolate the results to regional and global dynamics. Seagrass ecosystems are under worldwide pressure from coastal eutrophication, sediment loading and shoreline modification, and as much as 90 percent of the global resource has been lost in the last 100 years. It is now possible to determine the impact of suspended and dissolved materials on the radiance distribution of the underwater light field, and the impact of the submarine light field on metabolic carbon balance in seagrasses with great precision using radiative transfer theory. These complex mechanistic models were used to generate correlation matrices predicting the density and depth distribution of supportable seagrass populations from knowledge of chlorophyll, total suspended solids and bathymetry in turbid coastal environments in central California, Puget Sound Washington and Japan. This approach provides the predictive reliability of mechanistic models with the ease of use provided by correlations. It also offers portability to different environments without extensive ground-truth efforts or local re-calibration. These results can be used to assess potential seagrass habitat in individual coastal ecosystems and in larger global assessments of habitat potential in coastal zones throughout the world.

OS32J-06 1545h

Land Forcing and Coral Reefs: Terrestrial Runoff as a Factor in Coral Reef Distribution

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Coastal ecosystems such as coral reefs are increasingly in danger from non-local anthropogenic effects such as deforestation, land use, and pollution in inland river basins. These non-local pressures are channeled from a potentially large basin scale through freshwater discharge into the coastal zone. As a first estimate of a reef-to-runoff relationship, we examined global reef distributions as a function of total runoff within a 30' grid cell. We interpret the resulting correlation as meaning that runoff inhibited reef occurrence when runoff was greater than 10^10 m3/yr. Combining basin runoff and five additional variables (average sea surface temperature, minimum salinity, wave height, tidal range, Chlorophyll-A) selected to proxy the effect of runoff, increased predictive capabilities. The use of statistical representation of spatial and temporal variability allowed useful analytical comparisons of the environmental variables. Spatial and temporal summary statistics (mean, standard deviation, extremes) were summarized for each variable into a standard 30 spatial grid cell, providing a common framework for K-means clustering routine. Classification of runoff-related stresses were then extended, for example, by adding modeled sediment discharge to refine the prediction of areas of reef stress from human activities. Information on such environmental controls is important to understanding both paleo-environmental forcing of reefs and the potential effects of present and future human alterations to the hydrologic cycle.

OS32J-07 1600h

Zooplankton genomic database (ZooGene) project: integrating molecular, taxonomic, and oceanographic data

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An international partnership has been established to develop a zooplankton genomic (ZooGene) database of DNA type sequences for calanoid copepods and euphausiids. The ZooGene partnership includes four principal investigators and thirteen expert taxonomic consultants from seven countries. Either archival or new collections (arranged by each partner) are sorted for targeted species; species' identifications are confirmed by taxonomic experts. For each species, a DNA type sequence is determined for a portion of the mitochondrial cytochrome oxidase I (mtCOI) gene. The ZooGene database is being designed, created, managed, maintained, and distributed as part of the ongoing project; the data will be integrated into the Ocean Biogeographical Information System (OBIS). Issues being addressed include: 1) selection of a type DNA sequence for widespread and geographically-structured zooplankton species, for which there may be significant temporal and spatial intraspecific molecular variation; 2) establishment of linkages between molecular and oceanographic databases (e.g., the NCBI GenBank molecular database and the U.S. GLOBEC oceanographic database); and 3) relating spatial and temporal patterns of molecular population genetic and systematic variation to ocean structure and dynamics. ZooGene data are being used for uniform standards of species' identification, evaluation of the taxonomic significance of geographic variation within widespread species, identification of cryptic species, determination of evolutionary relationships among species, and design of rapid molecularly-based species' identification protocols. The ultimate goal of the ZooGene project is to provide a means to genetically identify all zooplankton species occupying the worlds oceans.

URL: http://www.ZooGene.org

OS32J-08 1615h

Growth and Fecundity of Marine Planktonic Copepods: Global Rates and Patterns in Relation to Chlorophyll a, Temperature and Body Weight

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Previous empirical studies have explored the role of temperature (Huntley & Lopez 1992), and temperature and body weight (Ikeda & Motoda 1978, Hirst & Lampitt 1998) in relation to the rates and patterns of growth in marine planktonic copepods. Unfortunately data used to construct these models is biased with measurements made predominately from eutrophic, shallow water coastal systems, and by the lack of inclusion of food availability terms. Consequently, earlier models may have systematic biases and overestimate rates when applied to oligotrophic situations.

To improve our understanding and ability to predict vital rates, we carefully screened and compiled a database of quasi in situ fecundity and growth measurements of epi-pelagic copepods that included temperature, body weight and concentration of various food proxies (n=4831). Here we present those results for the proxy that dominated the data set, namely total chlorophyll a concentration (n=2787).

Comparisons between broadcast and sac spawning copepods, and between adult and juveniles, were examined in relation to these independent variables. Although total chlorophyll a is not an ideal measure of the food environment available to copepods, significant relationships between growth / fecundity and Chl a concentration were found. The inclusion of total chlorophyll a data allowed issues regarding food limitation to be addressed, as well as the inconsistency of body scaling relationships that have previously been found. Including a food proxy measurement with temperature and body size data will improve subsequent models and allow greater accuracy when predicting copepod production and recruitment.

OS32J-09 1630h

Using the Biogeographic Information System "SeamountsOnline" to Describe Decapod Distribution Patterns on Seamounts

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Seamounts, with their high but varying levels of biodiversity and endemism, are good case studies for understanding processes that promote and maintain diversity in the oceans. SeamountsOnline is a project compiling existing information on the biota and environments of seamounts globally and making it freely available through a web-based portal. It is presented as a model for habitat-based data sets with species-level collection information. To display the abilities of the system in investigating large-scale patterns in biogeography, the distribution patterns of decapod crustaceans on two seamount chains, the Nasca/Sala-y-Gomez and the Hawaiian/Emperor, are described. The observed patterns are compared to predictions drawn from island biogeography theory (diversity decreases with distance from like habitat) and productivity-diversity models (diversity decreases with depth of seamount and export production from overlying waters).

URL: http://seamounts.sdsc.edu

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OS32J-10 1645h

Developing Interoperable and Scalable Ocean Biogeographic Information System

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Interoperability and scalability are an important set of objectives that have often been considered together in integrating heterogeneous systems. Interoperability is intuitively the precondition for any scalable network of systems while sustainable scalability calls for carefully derived strategy of interoperation. Considerations have been given to the issue of interoperability and scalability in OBIS structure and system development, based on its heterogeneous nature. In structuring OBIS, globally distributed data nodes are established for experts to store, manage, version and quality- control data in their specialty fields. Meanwhile, a proxy server is placed between data nodes and end user so that end user can do one-stop data shopping via a single user interface. Analytical tools and models can also be developed and housed in the proxy server, tapping into system-wide data resource. Such a structure combines the effectiveness and scalability of distributed systems with the efficient user access offered by an information portal. In OBIS system development, the standards on communication protocol, data exchange format, and common vocabulary are determined to effect interoperability and scalability. HTTP, the communication protocol for the World Wide Web, proves to be the adequate choice for communication between OBIS data nodes. XML, which is easily expandable, is chosen for data change format. Common vocabulary is derived based on international standards and a corresponding DTD/name space is put in use for all OBIS data nodes. Concurrent programming is used to develop the OBIS proxy server/information portal, which enhances scalability at programming level. Interoperability and scalability enhancement in structure and system development helps OBIS deliver its products with success and leads to solid information system and mature science program.